A new generation of Isocracking® catalysts

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The development of next generations of Isocracking® catalysts is the result of a lot of hard work by skilled scientists. Changes in crude supply and fuel specifications, limited capital, and economic incentives to hydroprocess lower-valued refinery streams using existing plant equipment are some of the challenges that spurred invention of the new generation of hydroprocessing catalysts. Catalyst innovations at Chevron Lummus Global (CLG) have answered these demanding challenges by providing cost-effective solutions. This paper describes two of CLG's latest, fifth generation catalysts: ICR 177 and ICR 178.

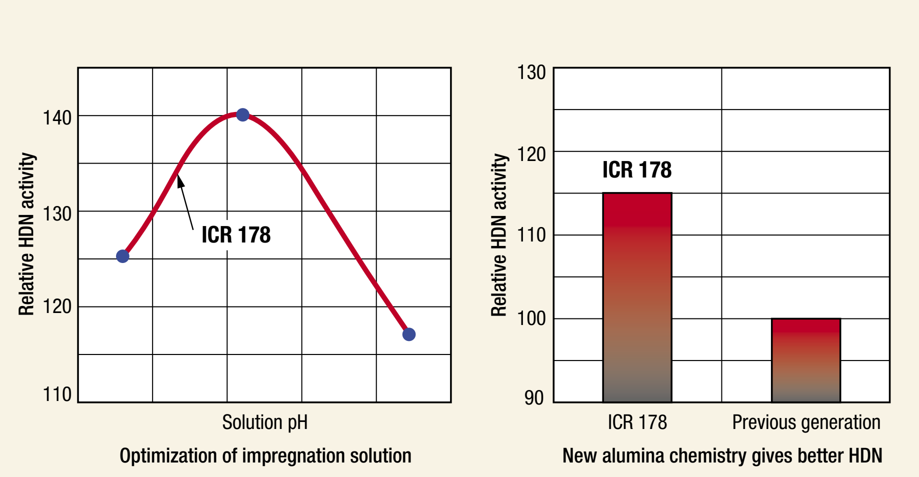

Fig. 1. ICR 178 VGO Hydrotreating Catalyst Improvements.

INTRODUCTION

Chevron has long been active in the research, development and commercialisation of hydrocracking technology.[1] During the 1950s, research at Chevron's Richmond Technology Center led to the development of Isocracking, the first modern hydrocracking process. The first Isocracking unit was started up in a licensee refinery in 1961, and Chevron's first Isocracking unit started operation in the Pascagoula refinery (Mississippi, US) in 1963. Both of these units used first-generation catalysts.

Continued research at Chevron led to the development of an improved, second generation of Isocracking catalysts based on the proprietary cogel technology.[2] These second-generation catalysts formed the basis for Isocracking units constructed in Chevron's Richmond and El Segundo refineries (California, US) and a second Isocracking unit built in Pascagoula. Also, numerous licensee Isocracking units were built and started up during the 1960s and 1970s.

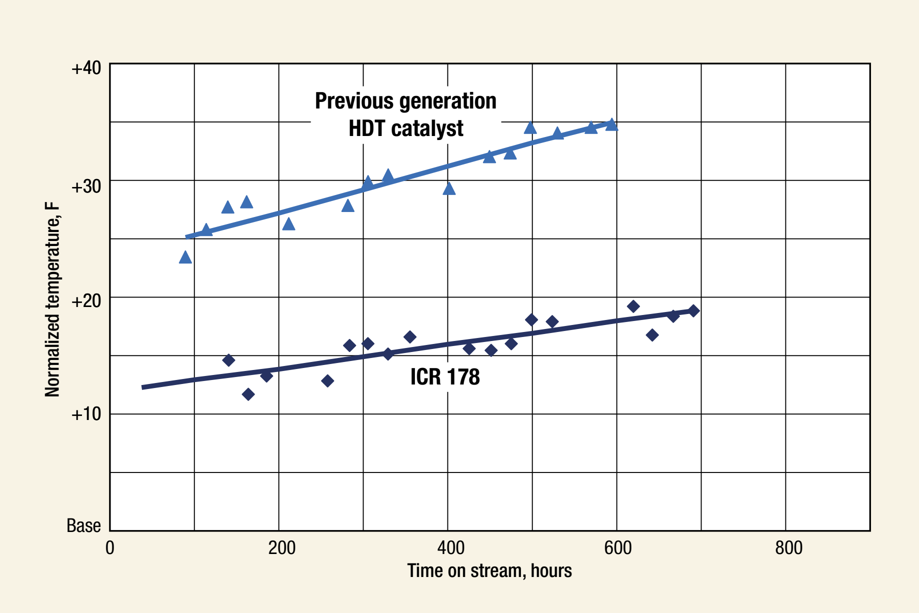

Fig. 2. ICR 178 Performance in Accelerated HDN Deactivation Test.

By the late 1970s, the third generation Isocracking catalysts were commercialised. These replaced second-generation catalysts in many Isocracking units, both in Chevron and licensee refineries.[2] In the late 1980's the fourth generation of Isocracking catalysts began replacing earlier versions.[3,4]

Each successive generation of catalyst technology has shown improved performance. The first Pascagoula Isocracking unit, for example, achieved a catalyst first cycle of 1–2 years; with the fourth-generation formulation, the second-stage catalyst lasted 10 years while processing higher throughputs of more difficult feed.

We are now entering the era of the fifth generation of Isocracking catalyst technology,[5] of which this paper describes two of our latest catalysts: ICR 177 and ICR 178.

NEW HYDROCRACKING PRETREAT CATALYST, ICR 178

CLG has recently commercialised a new VGO hydrotreating and hydrocracking pretreat catalyst, ICR 178. This new base metal/amorphous catalyst outperforms industry standard products in hydrodenitrification and cracking services.

ICR 178 owes its success to a number of formulation improvements. The hydrogenation function has been improved through the use of optimal solution pH during preparation. Figure 1 illustrates that the optimization of solution pH can increase HDN activity by approximately 15%. New alumina chemistry has increased the relative HDN activity by approximately 20%, also shown in Fig. 1.

These formulation improvements have increased HDN cycle length by a factor of 2 over the industry standard HCR pretreat catalyst. Fig. 2 depicts the relative performances in a laboratory pilot plant test.

ICR 178 is performing well in two Chevron hydrocrackers and in two licensee Isocracking units. This new HCR pretreat catalyst exhibits excellent hydrodenitrification and hydrodesulphurisation activity and has loaded at 10% lower bulk density than previous-generation catalysts.

Currently, CLG is improving this type of catalyst further, in order to obtain even better HDN activity and provide the flexibility to process very difficult straight-run and previously cracked VGOs.

NEW SINGLE-STAGE HYDROCRACKING CATALYST, ICR 177

Along with pretreat catalyst ICR 178, CLG developed a next generation of single-stage, once-through (SSOT) hydrocracking catalysts. This new generation of catalysts represents a major technological breakthrough.

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Do business locally and don't throw out technologies you trust

Many refining operations have spent a decade refocusing on their core competence and outsourcing the rest. That's fine, so far as it goes, says Paul Orzeske, Honeywell Process Solutions VP and General Manager. But, he warns, it can be a fraught wait when you find your outsourced expert is an international flight away. And be sure he or she has the skills you outsourced in the first place.

Paul Orzeske, VP and General Manager, Honeywell Process Solutions

I think a local presence, what we call in our jargon localisation, is one of the things that differentiates us, says Mr Orzeske. In a sprawling region that includes Europe and Russia, the Middle East and Africa, he has day to day responsibility that a $700 m business is running smoothly. And, if sales are anything to go by, it is.

The refining segment is going very well, he says. Sales are up by 21% compared with the previous year: "There's been a lot of spend in the last 18-24 months, following a long period of slowness," he says. "We're continuing to see a strong year this year."

So why is someone managing such an enormous region going out on a limb to stress the value of local relationships?

"A local staff is very important to our customers, and it is something we've worked very hard on. It dictates how we structure the business and means that we have 41 legal entities within my region alone.

"Local support doesn't mean flying someone in from the UK. For us, it means a local person, with local culture and language who can be left onsite to support the office. Engineers in local offices, long term, is our approach."

He points to Honeywell's 30 years in Moscow and its offices in other then 'iron curtain' countries which have been in place for 25 years. "Our latest office is in Algeria, and here again we'll seek local people. And it's the same in Saudi Arabia, Kuwait, Arab Emirates and North and West Africa."

■ The Abnormal Situation Management Consortium, in which Honeywell is one of many participants, has found that unexpected, unplanned-for outages represent a major cost in the refining industry

It means that Honeywell people encounter a variety of expectations.

"In the Middle East, Russia and Africa, the speed of getting a new unit up and running is everything," he says. "In more mature areas, there's the question of fitting in with the regulatory timetable."

Local skills may be a touchstone, but a skills shortage is something affecting the refining industry globally, says Mr Orzeske.

"The workforce is aging, companies are refocusing their skills and outsourcing what's on the margin and, as a result, they're expecting a lot more of us," he says.

Companies want to grow and support their operators, but they definitely don't want to have to support the underlying technology.

"They don't want to be experts in Ethernet technology or in upgrading to the latest Microsoft software and they don't want to be experts in virus control."

And just as refining companies have invested knowledge in people, they've also invested in learning to work with existing equipment.

"I suppose the other thing that differentiates us is that we've worked very hard so that our customers aren't forced to migrate from technology that is working very well for them," says Mr Orzeske. "We've put a lot of effort into backward compatibility.

"As an analogy, imagine you sell cars from a large showroom, and over the years you've carefully developed a set of Excel worksheets in which you basically analyse and run the whole business. Now, say Microsoft came out with a version of Excel that wasn't compatible with all of those Excel templates, for the company to get the best technology they'd have to throw away all the sweat and tears of the knowledge that's in all their Excel templates," he says. "In a refinery, that kind of knowledge includes what to do in an emergency, what to do in case of certain alarms. So a lot of effort has gone into giving people the latest technology without ripping out all the Input/Output, all the termination facilities."

So what about the prospect of newly built refineries in China and the substantial brownfield projects in the Middle East? Is the fact that these facilities are less fettered by backwards compatibility mean they can halve their workforce?

"Well, we are seeing a leapfrog effect in that the latest technologies are being brought into the newer refineries," he says. "And in many cases, you can be more effective with less people. But if you take a control room that once had 12 people, you might see 10 people there today.

"In people terms, the main difference is how someone chooses to do the implementation and then support. But it's in the technologies like maintenance predicting and asset management that some of the real gains lie.

"If you wait until a rotary pump fails, versus predicting when it might need some maintenance, then you can plan an orderly outage—or even repair it online. But if you wait until you have a catastrophic failure then you've got an entirely different problem—and the costs can be enormous.

"I don't have the figures to hand, but the Abnormal Situation Management Consortium, in which Honeywell is one of many participants, has found that unexpected, unplanned-for outages represent a major cost in the refining industry." ■

A new generation of Isocracking catalysts

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The new catalysts are characterised by an optimised pore size distribution that significantly enhances the wax (paraffin) hydroprocessing capability. As a result, these catalysts are redefining the activity-selectivity performance relationship of Chevron's Isocracking® catalyst portfolio.

The first of these new catalysts to be available is ICR 177. Relative to its state-of-the-art, base metal/zeolite predecessor catalyst ICR 142, ICR 177 is more active for conversion and provides a higher yield of base oils and other heavy distillates. Table 1 quantifies the advantage of ICR 177 over a current generation hydrocracking catalyst. ICR 177 enjoys a 21°F conversion activity advantage while providing the same yield structure in the SSOT hydrocracking of Middle East VGO.

Table 2 shows that the two Isocracking catalysts generate equivalent, high-quality middle distillates and bottoms products in SSOT mode. ICR 177 has been manufactured on industrial scale and is ready for commercial application. Development efforts are continuing to commercialize more catalysts from this generation so as to produce a higher yield of middle distillates with improved conversion activity.

CONCLUSIONS

CLG is continuously improving its catalyst technology to anticipate changes in fuel specifications and the desire to hydroprocess lower-value refinery streams. In this paper, CLG has shown two new catalysts that improve economics of existing plants and expand feedstock choices for the hydrocracker. CLG's latest VGO hydrotreating and hydrocracking pretreat catalyst, ICR 178, has been in successful operation in four commercial units. Our latest single-stage, once-through catalyst, ICR 177 is ready for its commercial application. ■

LITERATURE CITED

[1] A. G. Bridge and U. K. Mukherjee, "Isocracking—Hydrocracking for Superior Fuels and Lube Production," Handbook of Petroleum Refining Processes, 3rd ed., R. A. Meyers ed., Chapter 7.1, McGraw-Hill, 2003

[2] A. G. Bridge, D. R. Cash, and J. F. Mayer, "Cogels—A Unique Family of Isocracking Catalysts," 1993 NPRA Meeting, San Antonio, Tex., Mar. 21–23, 1993.

[3] A. J. Dahlberg, M. M. Habib, R. Moore, D. V. Law, and L. J. Convery, "Improved Zeolitic Isocracking Catalysts," 1995 NPRA Meeting, San Francisco, Mar. 19–21, 1995.

[4] M. M. Habib, A. J. Dahlberg, R. D. Bezman, and J. F. Mayer, "New Generation of ISOCRACKING Catalysts," 2000 NPRA Meeting, Mar. 26–28, 2000.

[5] A. J. Dahlberg, M. M. Habib, R. L. Howell, W. S. Louie, and U. K. Mukherjee, "Process and Catalyst Innovations in Hydroprocessing for Minimum Capital Solutions in Fuels Production," presentation to PETEM conference, 2002.

TABLE 1. SSOT Isocracking for Middle Distillates, Middle East VGO

	Current generation	ICR 177
Catalyst activity, °F	**Base**	**Base-21**
Yields		
C_1–C_4, Wt %	3	3
Naphtha, LV %	12	13
Kerosene, LV %	41	39
Diesel, LV %	**18**	**19**

TABLE 2. Product qualities in SSOT Isocracking for middle distillates

	Current generation	ICR 177
Kerosene		
Smoke point, mm	27	25
Freeze point, °C	–62	–64
Diesel		
Cetane index	58	59
Cloud point, °C	–9	–9
Bottoms		
N/S, ppm	0.2/12	0.3/9
Polyaromatic indicator, ppm	315	310